

Los Alamos

National Laboratory
Los Alamos, New Mexico 87545

SUBCONTRACT AWARD/ PURCHASE ORDER

ORDER NUMBER MUST APPEAR
ON OUTSIDE OF EACH PACKAGE
AND ON ALL SHIPPING PAPERS
AND INVOICES

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Operated by the Regents of the University of California under
Government Contract No. W-7405-ENG-36 Dated January 1, 1943

CONTRACT AWD/PO NO.
72232-001-03 43

AWARD/CONFIRMATION DATE	EFFECTIVE DATE	FUNDED AMOUNT	CEILING AMOUNT	CONTRACT TYPE
30 Jun 2003	01 Aug 2003	\$640,000.00	\$.00	Intra-Univ Transaction
ISSUED BY DEBRA CARLISLE	TELEPHONE (505) 665-2431	FAX (505) 665-8803	EMAIL dac@lanl.gov	
ADMINISTERED BY DEBRA CARLISLE	TELEPHONE (505) 665-2431	FAX (505) 665-8803	EMAIL dac@lanl.gov	

SUBCONTRACTOR
UNIV OF CALIFORNIA/SAN DIEGO
9500 GILMAN DR DEPT 0934
LA JOLLA, CA 920930934
Phone: (858) 534-0243

CONFIRMED BY:
Carlisle/Farrar 30 Jun 2003
QUOTED BY:
Lynelle A Gehrke 30 Jun 2003
Quote #: 2003-8152-Rev 1

SHIP TO:
LANL for US DOE
Bldg SM30 Bikini Atoll Road
Los Alamos, NM 87545
REF: 72232-001-03 43

INVOICE

Invoice must be mailed to:

Los Alamos National Laboratory
P.O. Box 1663
ATTN: Accounts Payable, M/S P240
Los Alamos, NM 87545
REF: 72232-001-03 43

INVOICE TERMS:
NET 30 DAYS
Term begins from receipt of goods or
receipt of invoice in Accounts Payable,
whichever is later.

The Subcontractor agrees to furnish and deliver all items or perform all services identified in this subcontract for the consideration stated herein. This subcontract expressly limits acceptance to the terms referenced herein and/or attached hereto, and any additional or different terms proposed by the Subcontractor are rejected unless expressly assented to by the University in writing.

ACKNOWLEDGEMENT - PLEASE SIGN AND RETURN PROMPTLY TO:

DEBRA CARLISLE M/S D442
P. O. Box 1663
Los Alamos, NM 87545

For the Subcontractor		For The Regents of the University of California	
Vendor's Reference Number			
Name and Title (Type or Print)		Name and Title (Type or Print)	
By		By	
(Signature of person authorized to sign)	Date Signed	(Signature)	Date Signed

Line Items Continued on Next Page

"ORIGINAL"

Los Alamos, New Mexico 87545

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SUBCONTRACT AWD/PO NO
72232-001-0343

ITEM	DESCRIPTION	QUANTITY	UNIT ISSUE	UNIT PRICE	EXTENSION	DELIVERY
0001	Task 1-FY03 Engineering Institute Fellowship and Joint Educational Program. Reference: Memorandum Agreement Appendix A-UCSD Statement of Work/Deliverables-Revision 1 Appendix B-Payment Schedule PERF. PERIOD: 31 Jul 2003 to 30 Sep 2004 FOB: Not Applicable or Required SHIP VIA: N/A (no freight involved)	NOT	TO	EXCEED	\$344,400.00	01 Sep 2004
0002	Task 2-FY03 Collaborative UCSD/LANL effort on Predator damage prognosis and reliability. Reference Memorandum Agreement Appendix A-UCSD Statement of Work/Deliverables-Revision 1 Appendix B-Payment Schedule PERF. PERIOD: 31 Jul 2003 to 30 Sep 2004 FOB: Not Applicable or Required SHIP VIA: N/A (no freight involved)	NOT	TO	EXCEED	\$130,000.00	01 Sep 2004
0003	Task 3-FY03 Collaboration between UCSD and LANL on effort to monitor structural integrity of structural joints. Reference Memorandum Agreement Appendix A-UCSD Statement of Work/Deliverables Appendix B-Payment Schedule PERF. PERIOD: 31 Jul 2003 to 30 Sep 2004 FOB: Not Applicable or Required SHIP VIA: N/A (no freight involved)	NOT	TO	EXCEED	\$165,600.00	01 Sep 2004
TOTAL CONTRACT AMOUNT					\$640,000.00	

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MEMORANDUM AGREEMENT

MERGER

This agreement supercedes the "Letter of Intent" between Los Alamos National Laboratory (LANL) and University of California, San Diego Campus (UCSD) for the Engineering Initiative for Research and Education, executed by UCSD on 12-19-02 and LANL on 01-07-03, said letter is now "Null and Void".

THIS MEMORANDUM AGREEMENT (hereinafter called "Agreement") is entered into by and between the University of California at Los Alamos National Laboratory (hereinafter called "Laboratory") and the University of California at San Diego Campus (hereinafter called "Campus") for research authorized under Prime Contract W-7405-Eng-36 between The Regents of the University of California (The Regents) and the United States Department of Energy (DOE).

I. SCOPE OF WORK

The services to be provided under this Agreement shall be in accordance with item description in Appendix A, UCSD Statement of Work/Deliverables-Revision 1. This Statement of Work may be modified by mutual agreement of the parties to this agreement.

II. TERM

The term of this Agreement shall be Upon Signature through September 30, 2004, unless extended by mutual agreement or terminated in the accordance with Article X entitled Termination. Except as necessary to comply with any reporting and closeout procedures, Campus shall discontinue performance of work on the last date cited above unless Laboratory extends the period of performance by written notice to Campus, as agreed upon by both parties.

III. OPTION TO EXTEND

Option to extend the term of the Subcontract:

(A) The University may extend the term of this Subcontract by giving written notice to the Subcontractor by the date specified as the due date or expiration date of the Subcontract. The exercise of an option to extend the term of this Subcontract shall be accomplished by a unilateral formal Subcontract modification.

(B) The term of this Subcontract may be extended pursuant to this provision for up to 54 additional months beyond the initial term. Such extension may be made from time to time or in one action as necessary to meet the needs of the University.

(C) If the University exercises this option, the extended Subcontract shall be considered to include this option provision.

(D) The total duration of this Subcontract, including the exercise of any options under this clause, shall not exceed 60 months.

IV. OPTION TO INCREASE/DECREASE FUNDING

Los Alamos National Laboratory reserves the right to Increase or Decrease funding as needed to continue the efforts between University of California, San Diego and Los Alamos National Laboratory.

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V. EXPENDITURES

Direct Labor	\$157,751.
Fringe	\$ 37,811.
Travel	\$ 18,850.
Other Direct Costs	\$570,311.
Indirect Costs	\$ 69,689.

The estimated cost of work to be performed under this Agreement is \$640,000.00

- A. Limitation of Funds - The amount presently available for payment by the University and allotted to this Agreement for all items of Section V is \$640,000.00. It is estimated that this amount is sufficient to cover performance by the University of California/San Diego Campus, through September 30, 2004.
- B. No costs incurred prior to the start date of this Agreement as stated above in Article II are authorized. Campus shall not incur costs and Laboratory shall not be obligated to make any payments under the Agreement in excess and waive any right to such cost of the amount obligated in the absence of a written modification or notice from Laboratory authorized personnel named in Article XII.
- C. If, and to the extent the amount obligated by Laboratory is increased, any costs Campus incurs before the increase that are in excess of the amount previously obligated shall be allowable upon Laboratory approval to the same extent as if incurred afterward.

VI. FISCAL AND ADMINISTRATIVE STANDARDS

Allowable costs and administration shall be governed by standards set forth in Office of Management and Budget Circulars A-21 and A-110 and the Prime Contract.

VII. INVOICING REQUIREMENTS AND PAYMENT

- A. Invoices shall be prepared in accordance with Campus' standard practices, consistent with invoices prepared to Government contracts. In addition to the standard information the invoices must contain the following information:

Individual Line item Cost breakdown.

- * UCSD will supply LANL with an attachment to each invoice.
The attachment will provide such documentation as may be required to justify any charges being assessed against this contract. This documentation at a minimum will include in the cost breakdown, line item number, travel, labor hours (students, staff), supplies and/or equipment
- * LANL has agreed to allow UCSD to invoice as needed on Equipment purchases. Equipment Purchase(s) will be itemized, line item number will be referenced and will attest that UCSD has made payment.
Invoices will not be approved until a Progress Report demonstrating that subtask has been completed for the same period has been submitted to, reviewed by and approved by LANL UTR. Reference: XIII "Authorized Personnel"
- * Reference Appendix B, current payment schedule.

- B. Campus shall submit invoices no more frequently than monthly, and not later than quarterly.
Los Alamos National Laboratory
Contract No. 72232-001-03 43
P.O. Box 1663
CFO-1, MS-P240
Los Alamos, NM 87545

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Invoice terms of payment shall be from receipt of goods or receipt of invoice in LANL Accounts Payable whichever is later. Payment shall be made by check to University of California, San Diego Campus, which will include the remittance invoice number. The check will be mailed to the address indicated on the invoice. Campus will notify Laboratory when incurred costs approach 75% of obligated funds. Campus shall provide Laboratory with an invoice marked "Final Invoice," notifying Laboratory that no further invoices or charges are forthcoming.

VIII. TITLE TO PROPERTY/EQUIPMENT

Property is inventoriable equipment identified by unique numbers assigned to it for accounting purposes.

- A. All property acquired with Laboratory funds becomes government property. Prior written approval from the contract administrator is required for purchases of any property not previously approved.
- C. Upon termination of this Agreement, all such property shall be reported to Los Alamos National Laboratory.
- D. Los Alamos National Laboratory will issue disposition instructions within 120 calendar days after termination of this Agreement. Property shall either be transferred to Laboratory at Laboratory's expense or retained by Campus for Campus' use.

IX. INTELLECTUAL PROPERTY

The parties hereby acknowledge that intellectual property rights are governed as if the campus were a non-profit subcontractor under the Prime Contract No. W-7405-ENG-36.

X. TRAVEL

Any travel between Los Alamos National Laboratory and University of California-San Diego Campus shall be in compliance with OMB A-21.

XI. REVIEWS AND APPROVALS

By executing this Agreement, Campus represents that all reviews and approvals required by The Regents/Campus policies have been conducted and obtained, including those pertaining to environment, health, safety, human subjects, and animal subjects.

XII. TERMINATION

This Agreement may be terminated without cause by either party upon 90 days prior written notice to the other party. Laboratory shall reimburse Campus for non-cancelable obligations and allowable costs incurred to the effective date of termination.

Both parties agree that should this contract require termination, affected students and staff will be assisted in relocation and placement to there original status to the best of the parties' abilities. However, such actions are not guaranteed.

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XIII. AUTHORIZED PERSONNEL

The following individuals are authorized to negotiate, modify, or terminate this Agreement:

The Regents of the University of California
Los Alamos National Laboratory:
Debbie Carlisle-Contract Specialist
P. O. Box 1663, SUP-1, MS D442
Los Alamos, NM 87545

The Regents of the University of California
University of California, San Diego Campus
Lynelle A Gehrke-Contract & Grant Officer
9500 Gilman Drive Dept. 0934
La Jolla, Ca. 92093-0934

The following individuals are authorized within the scope of work to provide technical direction or request supporting services for the Laboratory: LANL UTR
Los Alamos National Laboratory
Chuck Farrar
Phone: 505-663-5330

UC-San Diego Campus
Task 1: Professors: F Seible & V. Karbhari, and M. Todd
Task 2: Professors J. Kosmatka, J. Conte and F. Lanza di Scalea
Task 3: Professor M. Todd

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Appendix A: UCSD Statement of Work (Revision 6-03)
Solicitation No. 72232-SOL-03 43

Title of Project: LOS ALAMOS – UC SAN DIEGO EDUCATIONAL COLLABORATION

Purpose, General: This contract will formally establish educational collaborations and initiate discussions towards the establishment of an Engineering Institute to facilitate research and educational collaborations between Los Alamos National Laboratory (LANL) and the University of California, San Diego (UCSD). While the program is envisioned as a multi-year effort, the program will begin with this initial 6 month contract between the Weapons Engineering and Manufacturing Directorate and the Jacobs School of Engineering. Appended is the Letter of Intent framework agreement for the establishment of an engineering initiative between the Weapons Engineering and Manufacturing Directorate of the Los Alamos National Laboratory (LANL) and the Jacobs School of Engineering at the University of California, San Diego (UCSD) [Appendix 1].

The educational collaborations will focus on the development of Damage Prognosis Technology. Damage Prognosis is defined as the prediction in near real time of the remaining useful life of an engineered system given the measurement and assessment of its current damaged (or aged) state and accompanying predicted performance in anticipated future loading environments. By working collaboratively with industry partners, LANL and UCSD will help solve problems of national importance while also supporting ESA Division goals.

The focus of the current tasks and this proposal are to establish educational opportunities for students through joint collaborative efforts that this contract will sponsor between UCSD faculty and LANL staff. Also, discussions will be initiated towards the establishment of an Engineering Institute. The classroom educational focus of the proposed institute will be on the area of engineering simulations with an emphasis on validated simulations. It is envisaged that the educational programs will include a Master's of Engineering Degree offered in collaboration between the University of California San Diego and Los Alamos National Laboratory (LANL). The program will be accredited through UCSD. Courses will be taught at both UCSD and LANL by UCSD faculty and LANL staff pursuant to appropriate UCSD policies. The Master's Degree Program will be in the area of Validated Numerical Simulations and will involve both theoretical and applied learning. The degree will have a multidisciplinary curriculum focusing on the integration of predictive modeling, experimental diagnostics, and data interrogation culminating in a project-oriented capstone course on model validation and uncertainty quantification. Currently, no other institution offers a degree that combines these particular areas. Ph. D. students will also be able to focus on this area of study through participation in UCSD-LANL collaborative projects. Other educational programs offered by this Institute may include activities such as the Los Alamos Dynamics Summer School, short courses and possibly an industry-focused Bachelor's level new-hire training program in the area of structural dynamics.

Three tasks associated with the development of this institute are identified below. Currently, specific subtasks associated with only the first 6 months of each task are identified. It is anticipated that each task will be revisited at the end of the fiscal year and funding for the next year's subtasks will be allocated based upon the development of a specific set of subtasks for the next fiscal year as well as consideration of new tasks based on overall goals and needs.

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Appendix A: UCSD Statement of Work (Revision 6-03)
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Purpose, Task 1: Educational development is a critical component of the UCSD-LANL interaction. To initiate substantial interaction between LANL researchers and UCSD, LANL will provide 4 specially designated fellowships at the graduate level. Every effort will be made to identify U.S. citizens and/or permanent residents for these fellowships. The intention of these fellowships is to recruit the brightest graduate students for advanced degrees in the area of damage prognosis and validated simulations. The students are expected to spend some amount of time during the summer at LANL working on their research. In addition this task will provide funding support for the lease of space at LANL for educational and research activities and for the long-term development of a UCSD Engineering Institute located at LANL. A great amount of effort will be required to develop joint courses and the proposed degree program to the point where they can be submitted for administrative approval through proper channels at UCSD. At the end of the first year, as part of this task, faculty at UCSD and staff at LANL will submit a proposal for a formal degree program in validated simulations to administrators at UCSD to receive the appropriate approval for a new degree program.

Purpose, Task 2: Unmanned Air Vehicles (UAV's) are being used by the military for surveillance as well as by the science community for monitoring the environment. The vehicles are typically made of lightweight advanced composite materials to reduce their weight and improve their performance (longer flight times). Upon landing, the vehicles must be quickly inspected and maintained before being sent back on another mission. Without a pilot, there is very little that is known about its in-flight performance or problems except from what is concluded from its few autopilot sensors. What is needed is a system that will monitor the composite airframe (wings, fuselage, and empennage), assess its structural integrity, identify a maintenance schedule, and predict the remaining life of critical components (prognosis). Both LANL and UCSD will work together on system development. This system, which could either be an in-flight on-line system or a pre-flight modal/acoustic test, would monitor stiffness changes (flutter prevention), or strength reductions (fatigue), or ballistic damage. The system sensors could either be attached (strain gauges, accelerometers, piezo-patches) or embedded (fiber optics) into the structure, and it could be passive (sensors only) or active (embedded sensors and actuators). This sensor data along with reduced-order analytical models will be used to identify regions in the structure that need further inspection. In order to predict the remaining component life (prognosis), one needs a robust analytical structural model that correctly accounts for geometric and material uncertainties, as well as the uncertainties associated with current and future loadings and sensors. Methods used in structural reliability (uncertainty) analysis that will be investigated include Monte Carlo simulation, importance sampling, Bayesian up-dating, First- and Second-Order Reliability Methods (FORM and SORM) and finite element reliability analysis.

This proposed research effort will begin to develop the fundamental analytical and experimental tools that are needed to produce a prognosis system that can be applied to composite airframes. The efforts during the first six months include; (1) review methods of damage detection/inspection in composite sandwich and bonded structures, (2) review uncertainty techniques applied to structural health monitoring, (3) fabricate a few test-bed structural components that are represent critical components in composite airframes, (4) Investigate the ability of embedded- versus attached-sensors to identify regions of structural impact damage, and (5) begin the development of a prognosis software framework that incorporates future flight data and a model of the damaged aircraft structure. Future years efforts will concentrate on (1) building full-scale composite airframe components, (2) performing fatigue tests on composite components to improve the composite damage (remaining life) models, and (3) completion of the prognosis software.

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Appendix A: UCSD Statement of Work (Revision 6-03)

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Purpose, Task 3: The use of heterogeneous materials in aggregate structural systems is increasing for a number of applications where performance demands and/or cost considerations warrant such hybrid designs. For example, the U.S. Navy is considering such a hybridized design for the next generation destroyer DD-X surface ship, which has a composite material superstructure and a metal hull. Such a design involves many metal-to-composite bolted connections. Under normal in-service mechanical and thermal stresses, composite materials are known to creep over time, resulting in loss of pre-load at the connection. This pre-load loss leads to reduced functionality in the joint to support design loads and can ultimately lead to catastrophic failure through wear, fatigue, or stress rupture. Currently, the inspection and re-torquing of bolted connections is performed by rote schedule without regard to condition, but as the U.S. Navy officially transitions to a condition-based maintenance philosophy, an on-line, automated diagnostic condition assessment is needed to meet these new requirements. This need is further strengthened as a large manning reduction of up to 70% is expected to accompany the DD-X program. The primary goals for this task are (1) to identify the relevant time-frames for the creep-induced pre-load loss and subsequent failure mechanism(s) of these bolted connections; (2) to identify an appropriate diagnostic test or tests that can track these processes; (3) to identify an appropriate sensor system to obtain the proper measurements needed to complete the diagnostic test(s); (4) to develop predictive models and couple them with the diagnostic analysis and real-time loads monitoring for prognostic capability; and (5) ultimately, to develop and deliver a prototype fastener degradation diagnostic/prognostic system meeting U.S. Navy requirements in condition-based maintenance. Students that develop the signal processing, nonlinear dynamics, time-dependent plasticity material behavior, and statistical pattern recognition capabilities necessary to complete this task will have the technical background to directly impact LANL programs such as the advanced material modeling and data interrogation associated with our high-fidelity predictive modeling efforts that supports almost all large-scale nuclear weapons engineering programs and the pit manufacturing program.

Areas of Technical Advancement: Engineering Education, Advanced Sensor Systems, Structural Health Monitoring, Damage Detection, Damage Prediction, Materials Modeling, Model Validation and Uncertainty Quantification

Classification: All Tasks are Unclassified

Proposed Duration: Although it is understood that the contract will continue for 5 years, the initial contract is for the period August 1, 2003-September 30, 2004.

Current Tasks:

1. Engineering Institute Fellowships and Joint Educational Program.
2. Collaborative UCSD/LANL effort on Predator damage prognosis and reliability.
3. Collaborative UCSD/LANL effort to monitor structural integrity of structural joints.

Deliverables and Schedule:

Delivery dates specified below are predicated upon the subcontract approval date. Deliverable due dates are based on consecutive calendar days. Subcontract performance is expected to continue after initial performance period. The subcontractor shall obtain approval from the University Technical Representative in Advance of actual preparation with regard to the format of all deliverable.

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Task 1 Deliverables

Principal Investigators: Professors F. Seible, V. Karbhari, and M. Todd

Subtasks and Deliverables	Due Date (Days After Contract Award)
1.a. Identify steps to be taken w/in UC system for the development of educational program for damage prognosis and validated simulation	45
1.b. Develop details of fellowship program including interaction with Los Alamos for future years.	90
1.c. Develop preliminary proposal for master degree content	100
1.d. Discuss and plan with Los Alamos space needs and lease logistics to accommodate the program.	100

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Task 2 Deliverables

Principal Investigators: Professors J. Kosmatka, J. Conte, and F. Lanza di Scalea

<u>Deliverables</u>	<i>Due Date</i> (Days after contract award)
2.a Review of existing approaches for detecting damage in laminated composite structures. Identify all common aircraft-related failure modes. Review damage models for these failure modes.	45
2.b. Review of existing probabilistic and reliability-based methods for vibration-based structural health monitoring and damage identification.	45
2.c. Review embedded passive and active sensors for laminated composite structures.	45
2.d. Design and construction of laboratory test-bed structures. Examples include laminated composite sandwich plates, Bonded joint specimens, composite spars, etc.	100
2.e. Evaluate embedded and attached sensors for locating damage in composite airframe structures using damaged test-bed structural components	100
2.f. Investigate fatigue load profiles for aircraft structural components using published Navy and Air Force data.	100
2.g. Outline Prognosis software framework. Identify approaches for incorporating uncertainty methods.	100
2.h. Develop conclusions and make recommendations for next years studies. Submit final report and work with LANL personnel to publish and present results.	100

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Task 3 Deliverables

Principal Investigator: Professor M. Todd

<u>Subtasks and Deliverables</u>	Due Date (Days After Contract Award)
3.a Literature review of composite creep mechanism and failure mode(s) in hybrid bolted assembly	100
3.b. Procurement and delivery of composite-to-metal bolted assembly to UCSD	100
3.c. Design, procurement, and delivery of high-performance 3x3 fiber optic strain measurement system (in cooperation with Naval Research Laboratory)	100
3.d. Development of initial creep study test plan at UCSD	100

Equipment description:

- (1) Multi-channel, kHz-bandwidth, 3x3 hybrid SFP/MZI fiber optic strain measurement system for laboratory measurements: \$80K
- (2) National Instruments multi-channel 16-bit DAQ multi-function board and PC for conventional data acquisition: \$5K
- (3) Fiber optic laboratory equipment: grating sensor arrays at 1550 nm, patch cords: \$40K

BUDGET JUSTIFICATION

Task 1

- Funding for 4 students is requested to cover costs of tuition and fellowship stipends. These students will serve as specially designated LANL fellows and will interact extensively with personnel at LANL and faculty at UCSD. It is expected that they will spend some time during summer at LANL as well.
- Travel and per-diem for the students to travel to LANL and to stay at LANL for a period up to 2 weeks each.
- Funding is requested for staff and faculty support to initiate the development of plans and curricula for the Engineering Institute and for the joint degree program.
- Funding is requested to support leased space that will house these joint education and research activities.

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Task 2:

- One month of summer salary is requested for Profs. John Kosmatka, Joel Conte, and Francesco Lanza di Scalea. Each will be instructing students as well as helping to develop the long-term direction of the program.

Task 3:

- One month of summer salary is requested for Prof. Michael Todd who will be leading efforts in this task related to instructing students as well as assisting in developing plans for the Engineering Institute. He will also be spending a substantial period of time at LANL during this summer.
- All the equipment requested supports dual-use purposes in both acquiring necessary data as well as instructing students in the use and operation of state-of-the-art fiber optic measurement equipment. In addition, students will learn cutting edge skills in optical fiber splicing, cleaving, sensor/host preparation, and fiber componentry.
- Expenses in the category of supplies and materials include costs of fabrication of assemblies and test units that would be used in the instruction of students.